EFFECTS OF LONG TERM MOISTURE STORAGE ON CONCRETE TEST SAMPLES

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NAPTF Construction Cycle 6 Objective:

To investigate whether high strength concrete mixtures have reduced fatigue performance due to brittle behavior.

Test Method

- Build full scale rigid pavement test sections using three different portland cement concrete mixes, a “low flexural strength” mix (500 psi), a “medium flexural strength” mix (750 psi), and a “high flexural strength mix” (1000 psi).
- Perform traffic study using NAPTV to simulate aircraft loads.
- Supplement full scale tests with laboratory fatigue study using concrete beams made at time of construction.

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Naming Conventions:

Rigid Pavement Sections: MRS1, MRS2, MRS3

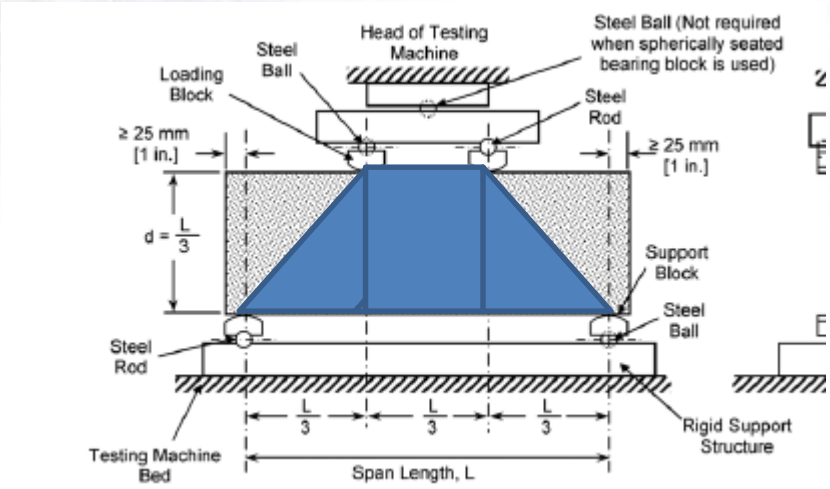
PCC Mix Designs: FLEX 500, FLEX 750, FLEX 1000

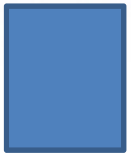
MRS1 built with FLEX 500 mix

MRS2 built with FLEX 750 mix

MRS3 built with FLEX 1000 mix

ASTM C78 Third Point Loading



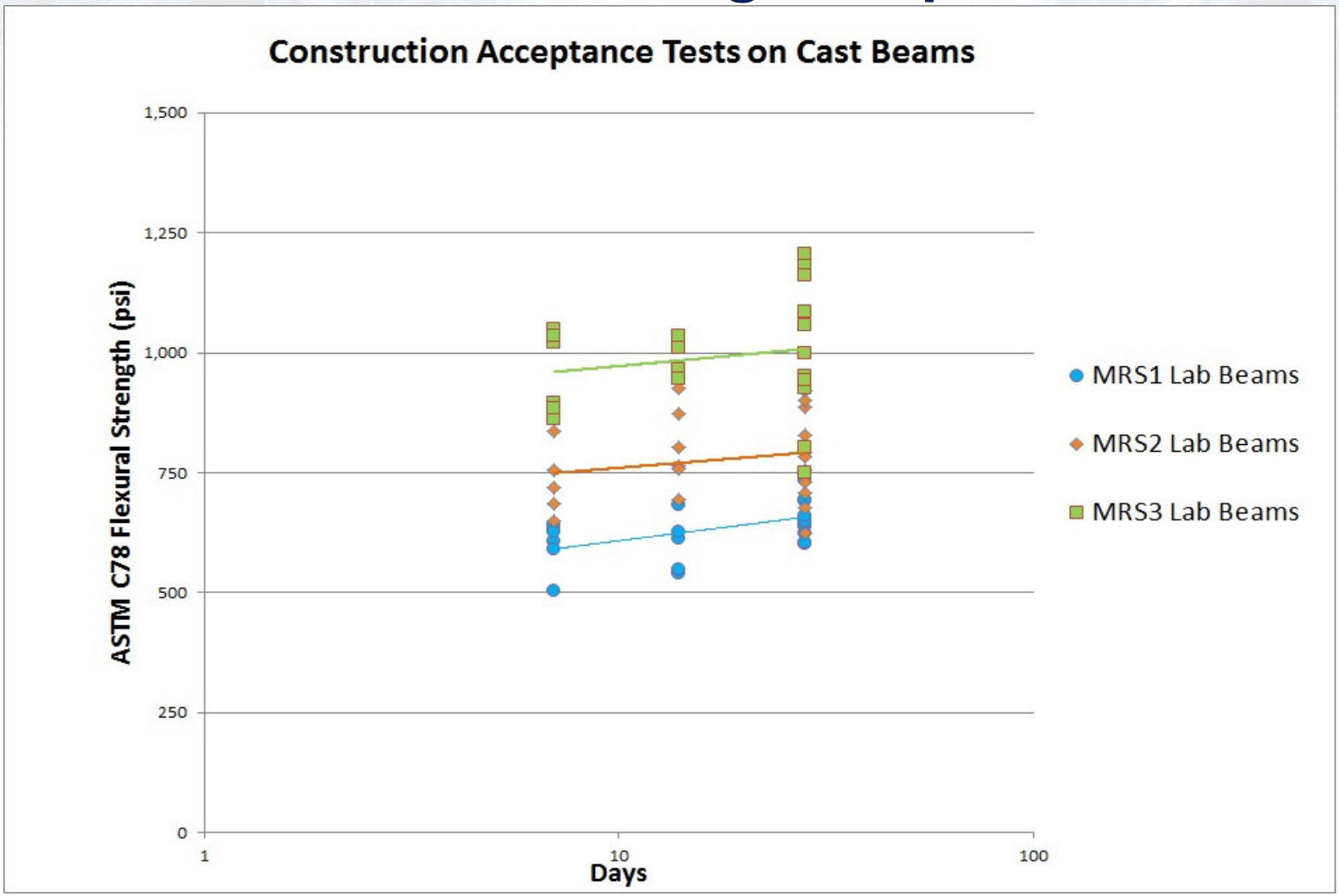


Bending Moment

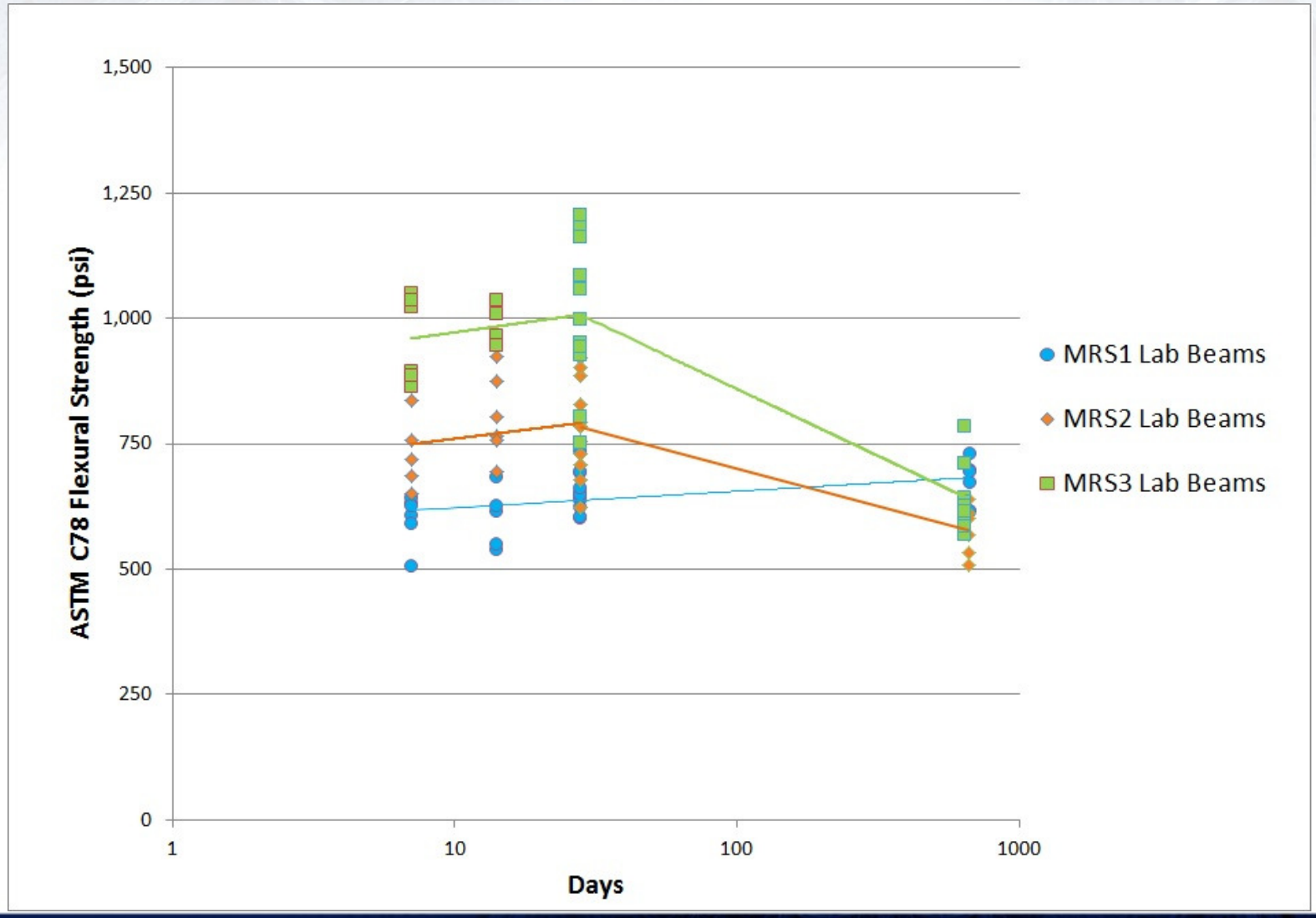
- Modulus of Rupture (Flexural Strength)
- Fatigue testing uses dynamic sinusoidal loads that are a percentage of flexural strength

  (Diagram Source: ASTM C78)

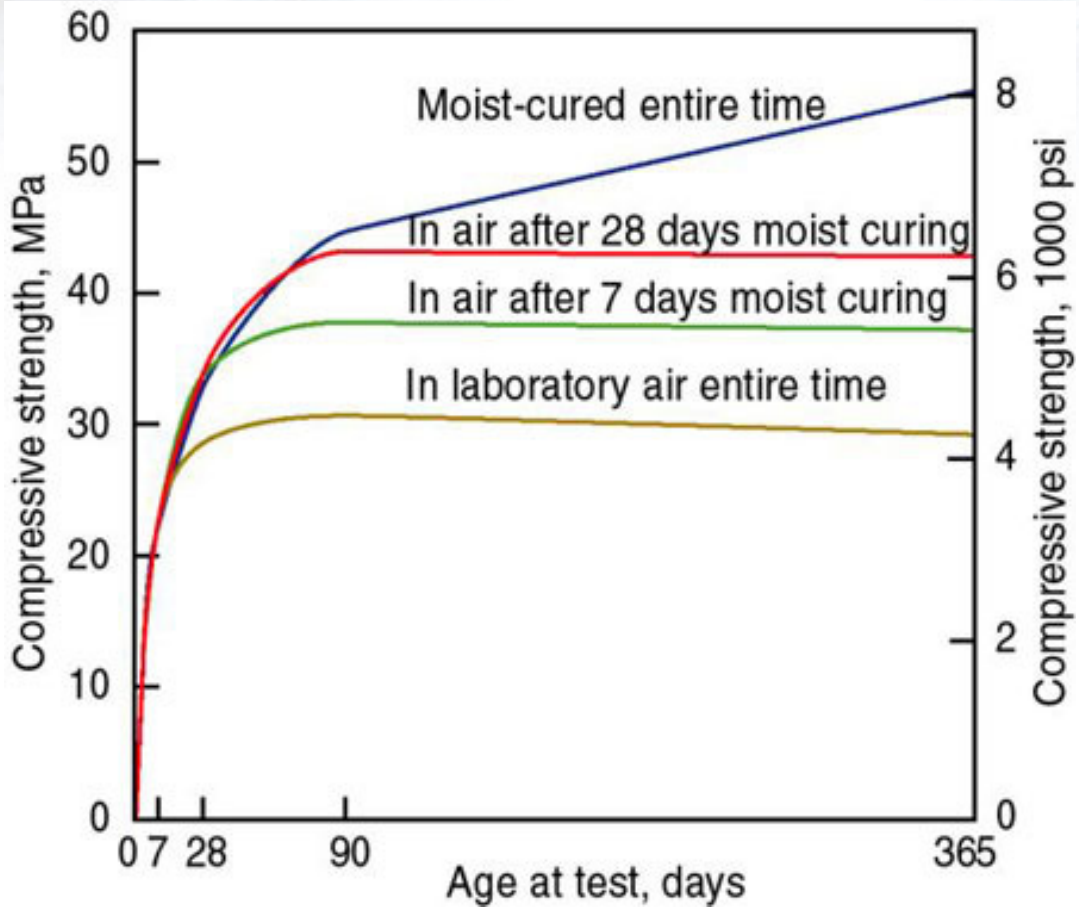
QA/QC Tests Met Design Requirements



ASTM C78 Flexural Tests Two Years Later…



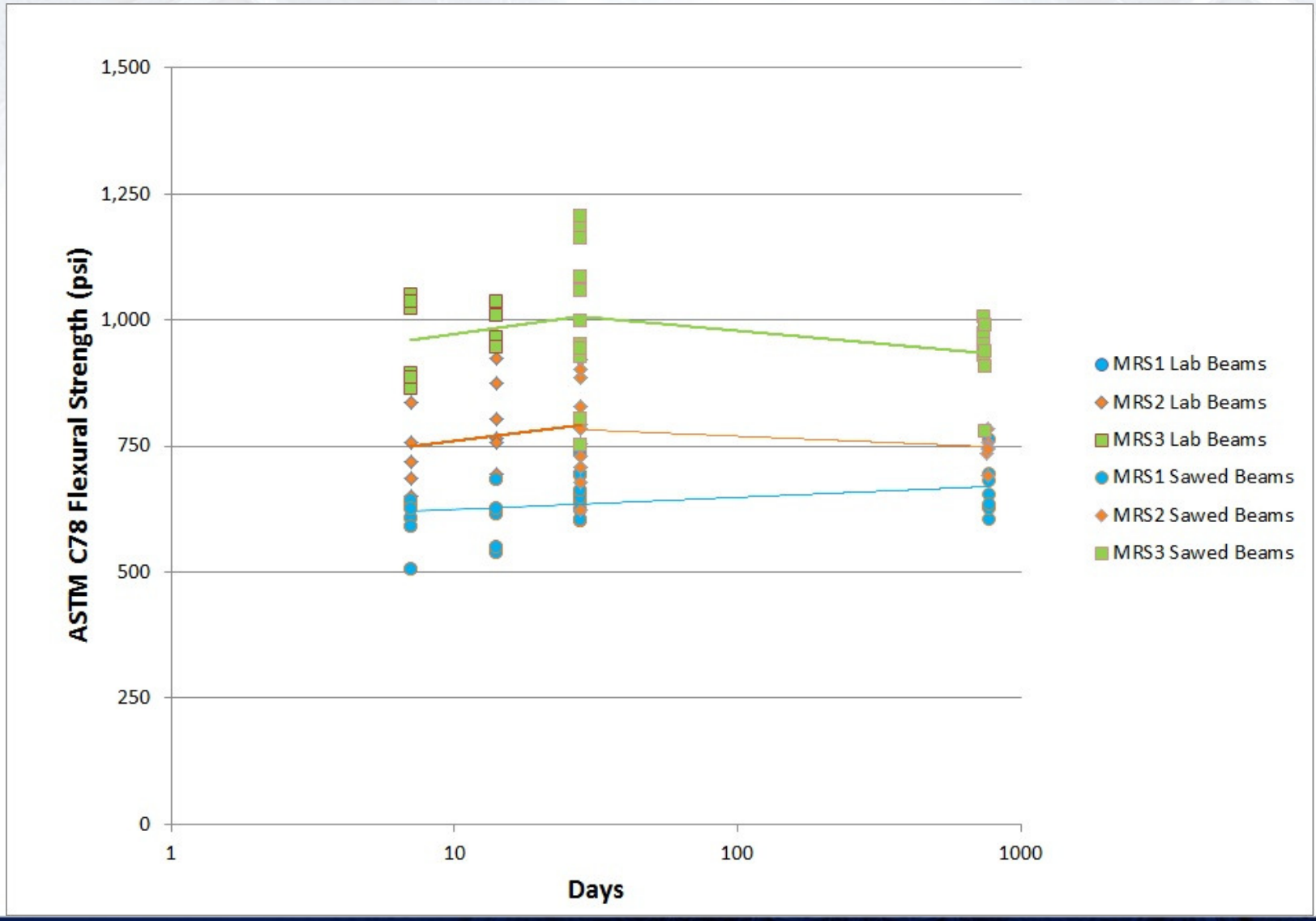
Under ideal conditions concrete gains strength over time with proper curing:



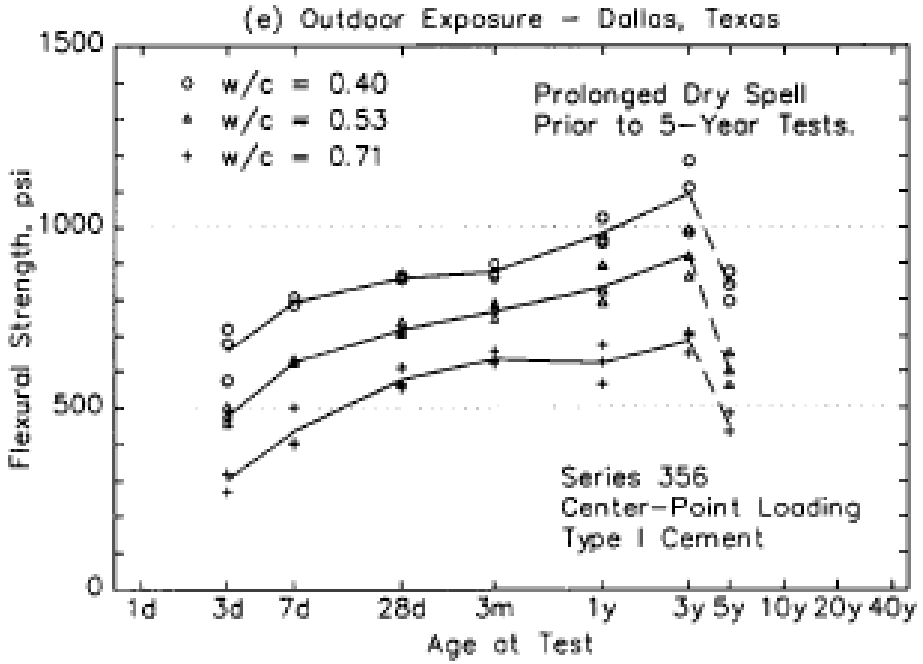
Source: Portland Cement Association

FAA Investigates, Saws Beams from Test Sections

ASTM C78 on Sawed Beams



Field conditions, not lab conditions, control strength gain (or strength loss) in the field



Source: *Evaluation of Long-Term Properties of Concrete, Sharon Wood, PCA, 1992*

FAA asks what happened to lab cured beams?

1. Testing Errors?
2. Damage in Transit to Laboratory?
3. Drying of samples?
4. Cement leaching?

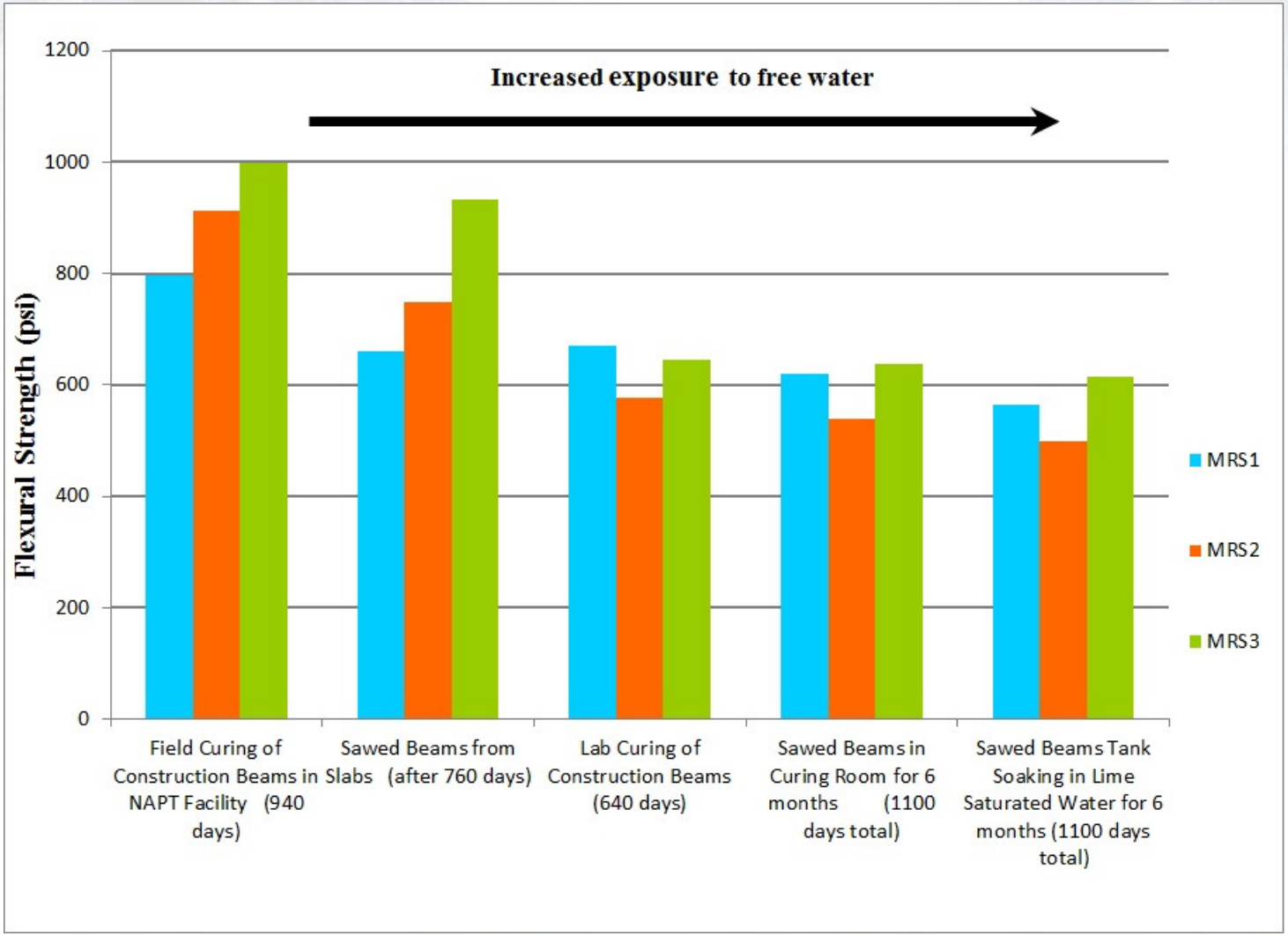
FAA asks what happened to lab cured beams?

1. Testing Errors? Similar flexural strength results at Penn State.
2. Transit Damage? Lab cured beams from MRS1 not affected.

3. Drying of samples? Test dry field beams.

4. Cement leaching? Place saw cut beams in curing room and others in lime-saturated water bath 6 months and then test.

Trend of all tests was more water, less strength (lime bath water strength slightly lower)



Observed white gel growth on MRS2 and MRS3 beams removed from 6 months in lime saturated water bath

Concrete samples sent to TTI for Petrographic Analysis

Analysis showed small amounts of ASR gel, but also delayed ettringite in micro-cracks of MRS2 and MRS3 samples.

MRS2 and MRS3 used different sources for aggregates than PCC mix used in MRS1.

Conclusions:

1. Field beams exposed to same conditions as in-situ pavement or sawed cut beams are more representative.
2. Storage of samples in moisture rooms or water tanks is for quality control to compare to concrete mix design tests.
3. Small amounts of Alkali-Aggregate Reaction or Delayed Ettringite may not show up in screening tests, but can be damaging if concrete given prolonged water exposure.

Thank You,
FAA
SRA
TTI